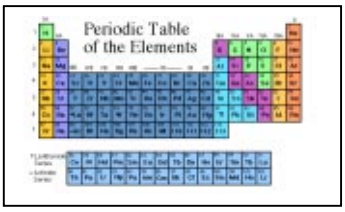
Cosmic Chemistry: An Elemental Question

Overview

Genesis Science Module



This module focuses on classifying and organizing information. With the periodic table as their guide, students choose various paths through question-finding exercises. Students experience the unique type of thought process that is required to predict missing information based on scant evidence and focused questioning. As they embark on a search for information, the students' quest is to find the missing evidence that is needed for further understanding of our solar system.

The Search for Critical Questions
- Teacher Guide
- Student Activity

Briefing

Use the Student Activity, The Search for Critical Questions, to create interest in learning more about solving problems by asking questions. The activity starts with students attempting to predict the characteristics of pieces missing from a jigsaw puzzle. It concludes with an examination of the questions that were formulated by lab groups as they searched for understanding.

Exploration of a Problem: Making Sense of the Elements
- Teacher Guide
- Student Activity

A Historic Overview: Mendeleev and the Periodic Table
- Student Text

The Modern Periodic Table
- Student Text

Exploration

In the activities to come, the teacher's instructional role is socratic. Through effective questioning, students are prompted to examine their logic as they attempt to solve two major mysteries – Mendeleev's landmark development of the Periodic Table of Elements, and the Genesis mission scientists' quest for elemental and isotopic abundance clues to the origin of the solar system.

Use the activity, Exploration of a Problem: Making Sense of the Elements, to generate discussion, leading students to examine some of their basic assumptions. This activity offers the teacher a snapshot of the class's present level of understanding about elements and their chemical characteristics. It is up to the discretion of the teacher to determine how much review or initial instruction of chemistry concepts is appropriate at this time.

Curriculum Connections

National Standards Addressed

Grades 9-12

Abilities Necessary to do Scientific Inquiry

Understandings about Scientific Inquiry

Physical Science
- Conservation of energy and the increase in disorder
- Interactions of energy and matter

Abilities of Technological Design

Understandings about Science and Technology

Science in Personal and Social Perspective
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Science as a Human Endeavor

Nature of Scientific Knowledge

Historical Perspectives

Student Mission

Students will practice problem-solving processes such as asking helpful questions and creating useful mathematical models. They will investigate isotopic abundance data from samples of material from the moon, Mars, and meteorites in an attempt to determine the origin of an unidentified sample.

Development of a Model: Analyzing Elemental Abundance
- Teacher Guide Part I

Development of a Model: Analyzing Elemental Abundances on Earth
- Student Activity

Atoms, Elements, and Isotopes
- Student Text

Development

Models corresponding to real events and objects help scientists understand and explain how things work. These explanations also generate logic-based models through incorporation of new findings. Terms such as *model* and *theory* become easier for students to understand as they construct a model and offer explanations based on critical questioning and applications of mathematical and logical concepts.

- During this more formal encounter with the investigative process, students in lab groups ask questions, construct models, make observations, and read and discuss text materials. Using the student activity, Development of a Model: Analyzing Elemental Abundance, each student records data, conducts analyses, and interprets relationships between evidence and decision making.
- Teachers may introduce technical vocabulary at this point in the learning cycle. The student text, Atoms, Elements, and Isotopes, can be used at this point, or later in the process, wherever deemed appropriate by the teacher.

Development of a Model: Analyzing Elemental Abundance
- Teacher Guide, Part II

Development of a Model: Analyzing Extraterrestrial Elemental Abundances
- Student Activity

Interaction/Synthesis

Students interact with peers in order to accomplish many of the tasks in the sections above. Each activity contains lab work done in groups, and preliminary and summary discussions are held as a class.

Students are asked to individually synthesize their knowledge by using what they have learned in group activities and discussions to answer a series of related questions in their laboratory notebook or in another format determined by the teacher.

- In the activity, Development of a Model: Analyzing Extraterrestrial Elemental Abundances, students determine the origin of material from Antarctica, comparing its oxygen isotope ratios to those of other identified samples. Students integrate all they have learned about asking questions and creating graphs to analyze data on these samples. The activity concludes with the class holding a public discussion in which lab groups argue for further support of this type of research.

Connecting Models and Critical Questions
- Teacher Assessment Guide
- Student Assessment Activity

Assessment

Use the final activity, Connecting Models and Critical Questions, to assess students' abilities to search for patterns in tables of data, to create mathematical models, and to communicate their findings with their peers.

- In Connecting Models and Critical Questions, students initially meet in lab groups to discuss information provided about a subset of the elements. They finish the assessment individually, creating a mathematical model to explain differences in chemical reactivity among these elements, analyzing the process of developing this model, interpolating from their model the characteristics of a hypothetical element, and planning a presentation to their peers on their model.

This science module, "Cosmic Chemistry: An Elemental Question," was developed by educators at McREL Eisenhower High Plains Consortium for Mathematics and Science.

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Englewood, CO